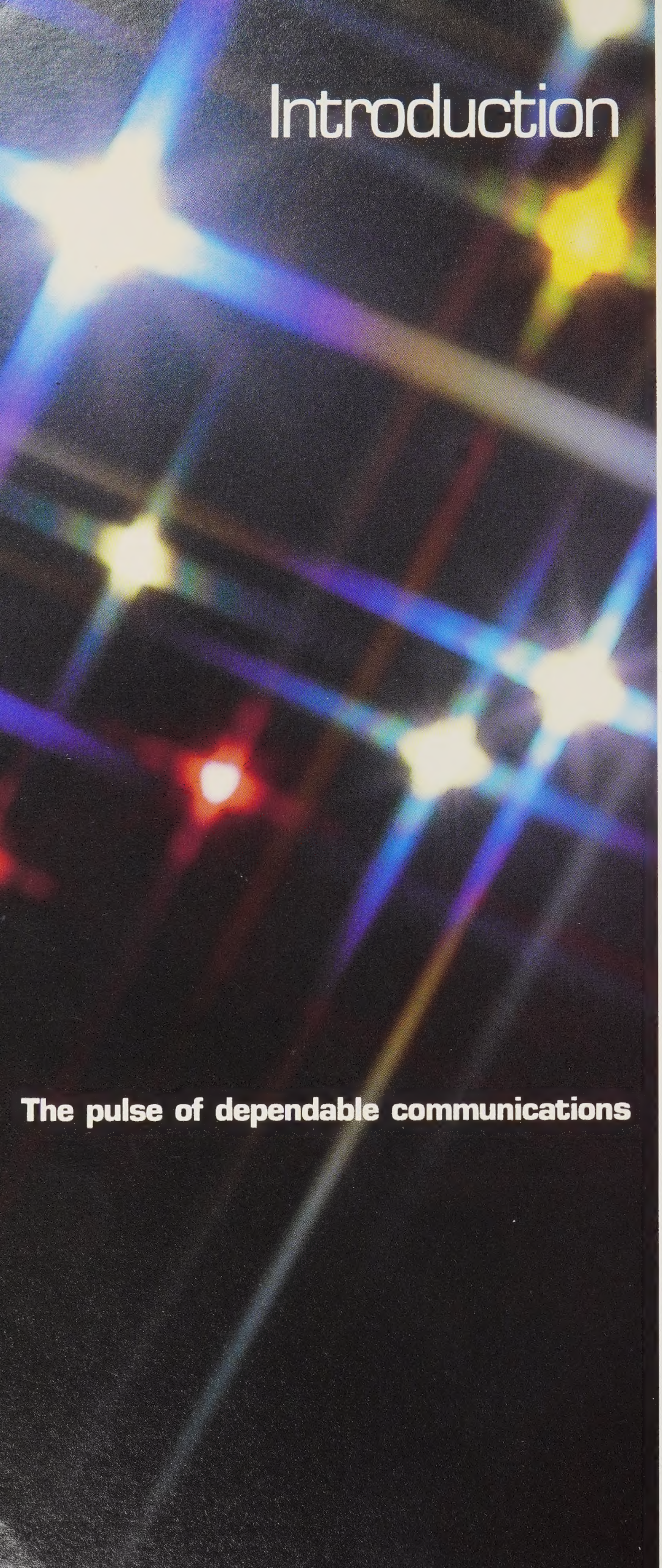
THE PULSE OF DEPENDABLE COMMUNICATIONS

CRYSTEK CRYSTALS

CUSTOM CRYSTAL CATALOG

A DIVISION OF WHITEHALL CORPORATION

Introduction



The pulse of dependable communications

Crystek is one of the country's leading manufacturers of high-reliability crystals covering the frequency range of 800KHz to 200MHz for military, commercial, satellite and two-way communication applications... serving the frequency control industry since the early 1950's.

Today, the Crystek name is recognized worldwide for its avant-garde technology and high standards of quality in exact frequency control and stability. This state-of-the-art technology is typified by the development of a precise technique of crystal temperature coefficient curve fitting which allows superior temperature compensation in mobile two-way radio and other critical frequency control applications. Included among the many similar applications for this vanquard technology are uses in mobile, portable and base station communications, as well as airborne systems of guidance and telemetry, telecommunications, and satellite communications for both commercial and military applications.

Manufacturing

Crystek has total in-house capability to manufacture quartz crystals and complete oscillators from raw quartz to the finished product.

In the last 3 years, several million dollars were invested in new manufacturing and testing equipment, enabling us to stay in pace with the rapid evolution in the hi-tech electronic market.

State-of-the-art processing and measuring equipment throughout the operation is the key to maintaining our high quality at competative prices.

Quality Assurance

Crystek's quality control begins at the door with incoming inspection of all raw materials. In-line inspection at every critical point in our manufacturing process is another assurance that a Crystek crystal meets the tight tolerance, high-reliability standards upon which we insist, as well as precise correlation to your equipment or other requirements. Calibration for all "standards" and test equipment is traceable to the National Bureau of Standards.

Engineering

Crystek's Management, Engineering and R & D Teams are knowledgeable in the latest of crystal technology and manufacturing techniques.

Crystal Design Engineers analyze the customers crystal specifications and with the aid of special dedicated computers determine the required, most reliable and economical design.

Sample crystals are quickly made and all crystal parameters are measured and recorded.

Computerized production control systems, as well as state-of-the-art processing techniques and 100% final test for frequency, impedance, motional capacity, motional inductance and frequency vs. temperature are further assurance that Crystek products meet or exceed all mechanical and electrical criteria of the crystal design.

Quartz Crystal Theory

Quartz is a piezoelectric material and is capable of transforming electrical energy into mechanical energy and visa versa. The equivalent circuit of a quartz crystal is illustrated in Fig. 1 and is useful to explain the crystal resonator.

Under ultra pure vacuum (10-7 TORR) a thin metal film (silver, aluminium, gold) is deposited on both sides of the quartz blank in the form of a "keyhole pattern" type electrode. (Fig. 2)

FREQUENCY:

The frequency of a quartz crystal is determined by its' mode of vibration and the physical dimensions of the quartz plate.

The type of vibration is a thickness shear and is either fundamental, third, fifth or higher mode depending on the intended application. (Fig. 3)

The type of cut used is an "AT". The "AT-cut" is the position of the plane of the quartz plate in relations to the major axis of the quartz bar. Fig. 4 illustrates the relationship of the "AT-cut" versus the major crystallographic axis in the cultured quartz bar. The thickness of the "AT-cut" quartz plate determines the frequency of the crystal and the frequency is calculated from the equation:

$$F = \frac{65.5}{T}$$

T = INCHES
F = KILOHERTZ

Crystek crystals cover the freqency spectrum of **.8MHz - 200MHz.**

FREQUENCY STABILITY

The frequency of a quartz crystal is required to stay within specified limits (tolerances in p.p.m.) over a given temperature range and during a required period of time. The change of frequency versus temperature is called the T/C.

The change of frequency over a period of time is called "Aging".

The T/C of a crystal depends on several factors but mainly on the angle at which the quartz crystal is cut from the original stone. In controlling the angle of cut (tolerances as close as ±¼ minutes of arc) which is measured by a x-ray diffraction method, crystals are manufactured with tight frequency tolerances over a wide variety of operating temperatures.

A general illustration is found if Fig. 5 and is only Typical.

Changes in angle ⊖ produce the changes in maximum and minimum points permitting an orientation to be found that minimizes frequency change over a specified temperature range.

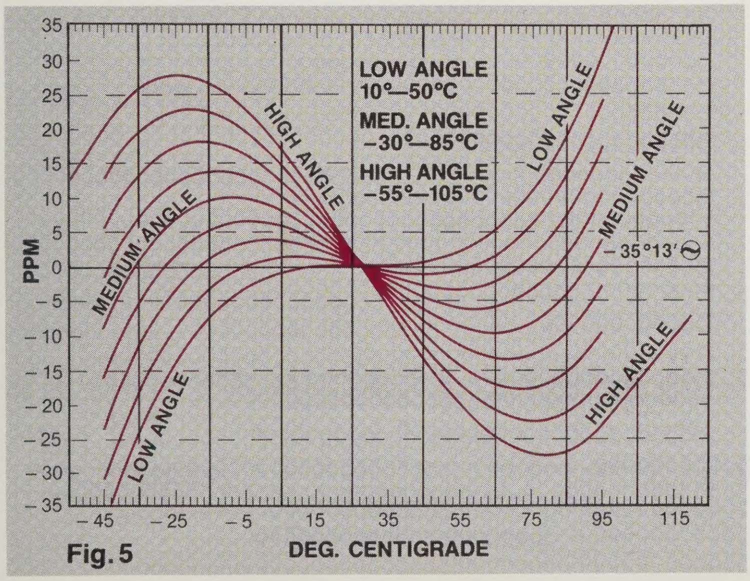


Fig. 5

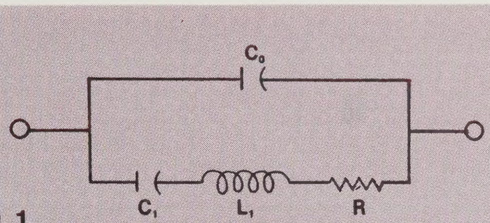


Fig. 1

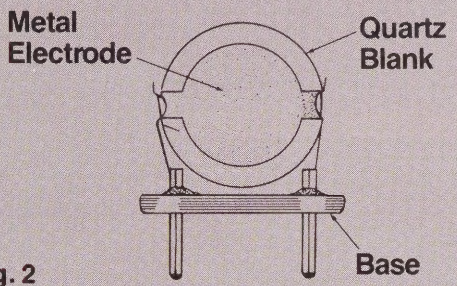


Fig. 2

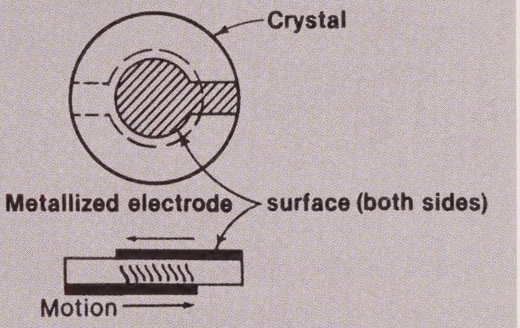


Fig. 3 THICKNESS-SHEAR

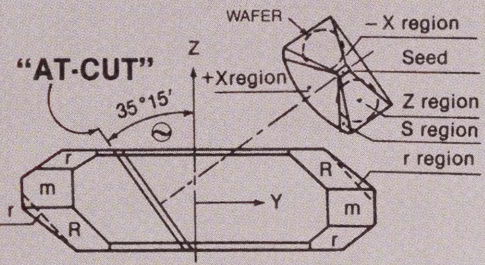


Fig. 4 The Wafers cut from the lumbered Y-bar are diced and the square blanks rounded.

RECOMMENDED PUBLICATIONS

"Crystal Oscillator Design & Temperature Compensation"
By: Melvin E. Frerking — VanNostrand Reinhold Co.

"Design of Crystal and other Harmonic Oscillators"
By: Benjamin Parzen — Wiley/Interscience

"Guide to the Specification and Use of Quartz Oscillator Crystals"
Published by the Radio Communications & Electronic Engineering Association, London, England

"Introduction to Quartz Crystal Unit Design"
By: Firgil Bottom — Van Nostrand Reinhold Co.

Crystal Design Information

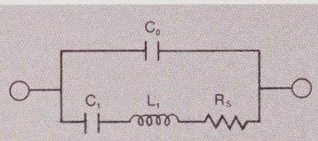


Fig. 1 SERIES RESONANCE

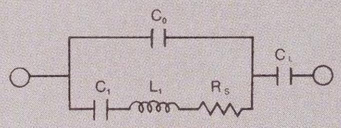


Fig. 2 PARALLEL RESONANCE

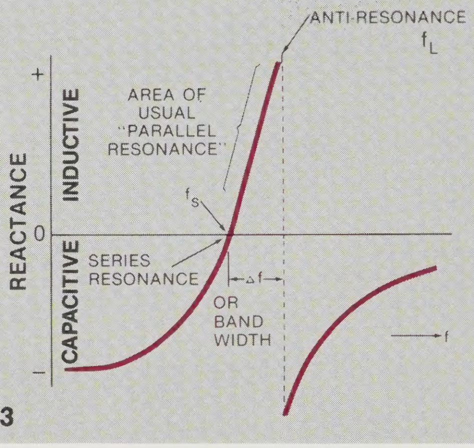


Fig. 3

TYPICAL RESISTANCE CHARACTERISTICS

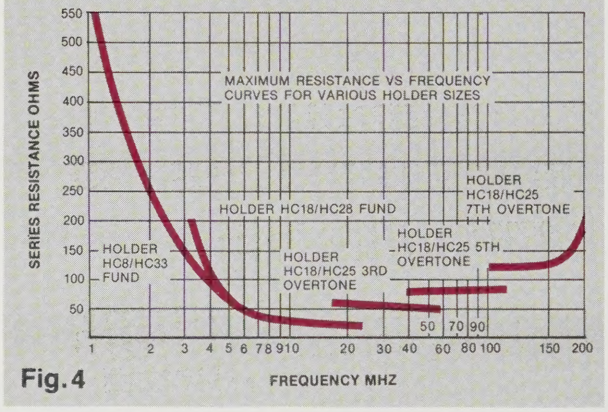


Fig. 4

EQUATIONS:

f_s= (Series) Frequency $= \dfrac{1}{2\pi \sqrt{L\ C}}$

$f_L - f_s = \Delta f = \dfrac{f_s C_1}{2\ (C_0 + C_L)}$

L = Motional Inductance $= \dfrac{1}{4\pi^2.F_s^2.C_1}$

C_1 = Motional Capacitance $= \dfrac{2\ (C_0 + C_L)\ \Delta f}{f_s}$

Q = Quality Factor $= \dfrac{2\pi.f_s\ .L}{R_s}$

R_s = Series Resistance $= \dfrac{2\pi.f_s\ .L}{Q}$

C_0 = Shunt Capacity $= \dfrac{f_s.C_1}{2.\ \Delta f} - C_L$

C_L = Load Capacity $= \dfrac{f_s.C_L}{2\ .\Delta f} - C_0$

P_L = Pullability $= \dfrac{C_1\ .\ 10^6}{2\ (C_0 + C_L)^2}$

LEGEND:

f—Nominal frequency in Hz

f_s—Series resonant frequency Hz

f_L — Anti-resonant frequency in Hz

L — Inductance in Henrys

C_1—Motional capacity in farads

C_0—Static capacity in farads

C_L—Load Capacity in farads

R_s—Series resistance Ω'

Q—Quality factor

P_L—Pullability (ppm/pf)

Mode of Oscillation

Two types of resonance are recognized: series and parallel and both are used in fundamental or higher mode of operation, (3rd, 5th, 7th, etc).

SERIES AND PARALLEL RESONANCE:

Series Resonance (Fig. 1)

A crystal operating at series resonance (fs), looks resistive in the circuit. Thus its impedance at **fs** is near zero. In a well-designed series resonant circuit, correlation is not a problem and a load capacitance does not have to be specified.

Parallel Resonance (Anti-resonance) (Fig. 2)

A crystal operating at parallel resonance (**f_L**), will look inductive in the circuit. The crystal's impedance reaches its peak at **f_L.** A change in circuit reactance values will have the effect of pulling the frequency of the crystal. If the crystal is to be used at parallel resonance, the load capacity **should always** *be specified.* Load capacity is the dynamic capactiy of the total circuit measured across the crystal terminals. In a parallel circuit design, the load capacity should be selected to operate the crystal at a stable point on the **f_s to f_L** reactance curve (as close to fs as possible). (Fig.3)

When a load capacitor is connected in series with a quartz crystal, a different frequency results, called a load resonance frequency. This same frequency also occurs if the same capacitor is connected in parallel with the crystal unit. In practice the total circuit load capacitance consists of the sum of different stray capcitances and the load capacitor. The frequency change caused by the load capacitance is **f_L.** (see equations)

Crystal Parameters

EQUIVALENT SERIES RESISTANCE:

The resistance of a crystal (E.S.R.) is the equivalent impedance of the crystal measured at series resonance in OHMS.

The resistance is normally specified by a maximum value only. The E.S.R. is controlled by the blank diameter and also the different curvatures of the blank surfaces. For typical Rs values see Fig. 4.

SHUNT CAPACITANCE:

The quartz crystal consists of a dielectric (quartz) with a metal electrode on each side. This capacity is C_e and in addition to this is the holder capacitance C_h.

The value of $C_0 = C_e + C_h$ is called the shunt capacity and a maximum value in picofarad is specified. (Typical C_0 = <7pf)

LOAD CAPACITY:

If the crystal is used at parallel resonance, the load capacitance should always be specified. This load capacitance is the dynamic capacitance of the total circuit measured or computed across the crystal terminals. C_L (pf)

INDUCTANCE AND MOTIONAL CAPACITANCE:

The motional arm in fig. 1 contains the inductance L_1 and capacitance C_1. In normal designs the C_1 is maximized and L_1 minimized (required for low spurious modes). C_1 is important for oscillator designs in order to calculate the pullibility of the crystal frequency.

SPURIOUS MODES:

Spurious Modes are "inharmonic modes" of vibration of the quartz plate and are also called "unwanted modes".

Spurious modes are suppressed by special designs and typically are kept 6db below the main mode of oscillation. The resistance value of a "spur" should be at least two times the series resonance resistance of the crystal.

DRIVE LEVEL

Drive level is the power at which the crystal is driven during oscillation and is specified in milliwatts. Drive level specs are needed to insure accurate correlation and measurments.

AGING:

The systematic average change of frequency versus time is specified as a rate of aging: i.e. 3ppm/year. Aging is a deterioration of the frequency determining parameters caused by factors such as; type of hermetic seal, dirve level, surface contamination, etc.

Standard "Custom Design" Low Frequency

FUNDAMENTAL MODE .800 - 2.000 MHZ

Crystal Selection Guide

CRYSTEK P/N	FREQ. RANGE MHZ	R_s (Max)	25°C FREQ. TOL. SETTING	STANDARD TEMP. RANGE °C	FREQ. TOL. OVER TEMP RANGE	HOLDER TYPE
LF-1	.800- .999	600-550	±.005% ±50ppm	−30°C to +70°C	±.005% ±50ppm	HC-6/U HC-33/U SMALLER HOLDER TYPE ON REQUEST
LF-2	1.000-1.200	550-450				
LF-3	1.201-1.600	450-350				
LF-4	1.601-2.000	350-250				

For closer freq. tolerances use the following code in addition to the **Crystek** P/N.

Code	Room Temp °C Tol. Setting	Temp Range °C −30°C to +70°C
−1	±25ppm	±50ppm
−2	±10ppm	±50ppm
−3	±25ppm	±25ppm
−4	±10ppm	±25ppm

For **oven** type crystals use the following code.

Code	Specify Reference Temp °C	Max Δ f at Ref. Temp
−5	+65°, +70°, +75°, +80°, +85°	±20ppm
−6	Oven Temp Stability ±1°C	±10ppm

OVEN CONTROLLED CRYSTALS (OCC)

A small oven or warmer is used to control the temperature environment of an O.C.C. The oven temperature is normally at an elevated temperature 65, 75, 85 (degrees centigrade). The oven minimizes the effects of the external temperature variances. The reference temperature of the oven matches the temperature of the crystal frequency curve at a point where the frequency deviation is at a minimum (upper turn point). All ovens or warmers exhibit a warm-up characteristic and the frequency of the crystal may during this "warm-up" period exceeds the maximum allowed tolerance. As the oven reaches its temperature set-point the frequency stablizes within its specified tolerance. Oven temperature stabilities are critical and therefore proportional controlled ovens are recommended.

LOAD CAPACITY:

Standard C_L (20, 32pF)
C_L values between 12pF and Series resonance can be specified without additional cost.

SHUNT CAPACITY:

Typical C_0 = <7pF.

DRIVE LEVEL:

1-5 milliwatt recommended.

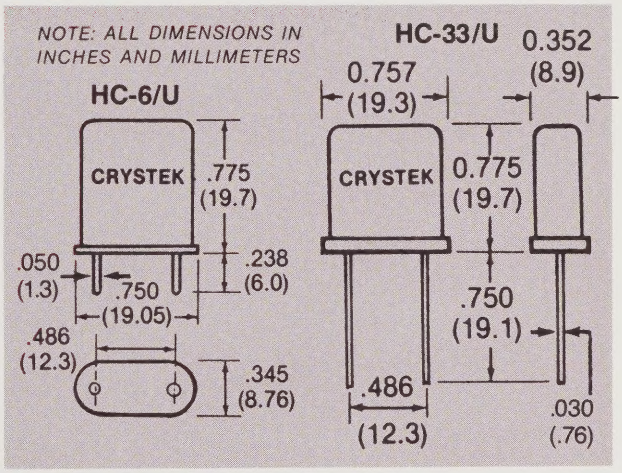
TYPICAL AGING

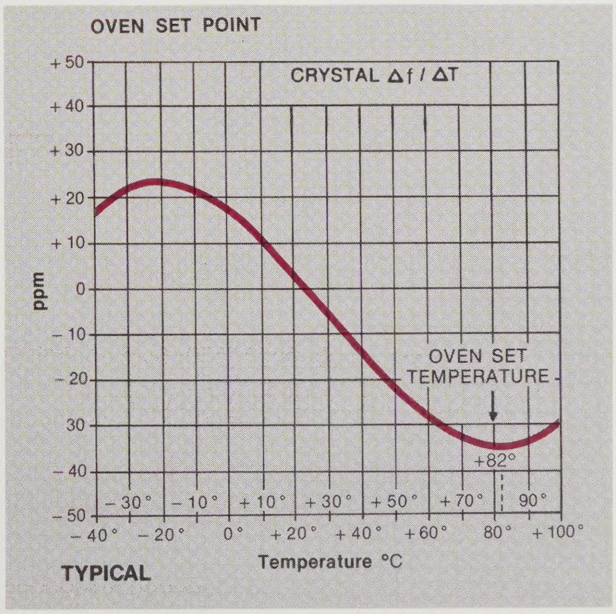
<3ppm for Coldweld.
<5ppm for Resistance Weld.
<10ppm for Solder Seal.
Standard types are solder sealed or resistance welded. Coldweld sealing is available at a slightly higher cost.

TO ORDER:

- Specify Crystek P/N. (Code)
- Crystal Frequency/MHz
- Holder Type (HC6/U or HC33/U)
- Load Capacitance or
- Series Resonance

Crystal Holders:





Standard "Custom Design" Medium Frequency

Crystal Selection Guide

FUNDAMENTAL MODE 2.- 30. MHZ

CRYSTEK P/N	FREQ. RANGE MHZ		25°C FREQ. TOL. SETTING	STAND TEMP RANGE °C	FREQ. TOLERANCE OVER TEMP RANGE	HOLDER TYPE
MF-1	2.000- 3.400	FOR TYPICAL R_s SEE FIG. 1	±.005% ±50ppm	−30°C To +70°C	±.005% ±50ppm	HC-6/U — HC-33/U
MF-2	3.401-16.000					
MF-3	16.001-20.000					
MF-4	20.001-22.000					
MF-5	22.001-25.000					
MF-6	2.200- 2.000					HC-18/U-HC-25/U
MF-7	2.001- 3.000					
MF-8	3.001- 5.000					
MF-9	5.001-12.000					
MF-10	12.001-20.000					
MF-11	20.001-25.000					
MF-12	25.001-30.000					
MF-13	6.000-10.000					HC-44/U
MF-14	10.001-18.000					
MF-15	18.001-25.000					
MF-16	25.001-30.000					

TYPICAL RESISTANCE
VS FREQUENCY
CHARACTERISTICS

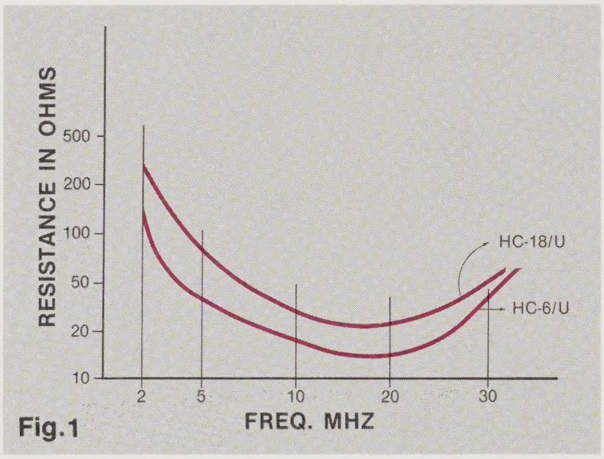


Fig.1

For closer freq. tolerances use the following code in addition to above **Crystek** P/N.

Code	Room Temp 25°C Tolerance Setting	−30°C to +70°C
−1	±25ppm	±50ppm
−2	±10ppm	±50ppm
−3	±25ppm	±25ppm
−4	±10ppm	±25ppm

For **oven** type crystals use the following code.

Code	Reference Temp °C	Freq. Tol.
−5	+65°, +70°, +75°, +80° & +85°	±20ppm
−6	Oven Temp Stability −1°C	±10ppm

LOAD CAPACITY:

Standard C_L (20, 32pF)

C_L values between 12pF and Series Resonance can be specified without additional cost.

SHUNT CAPACITY:

Typical C_0 = < 7pF.

DRIVE LEVEL:

recommended
2-10 MHZ — 5M Watt Max.
10-20 MHZ — 2M Watt Max.
20-30 MHZ — 1M Watt Max.

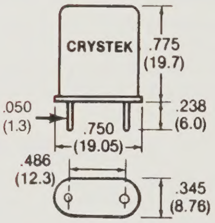
TYPICAL AGING:

- $<$ 3 ppm for Coldweld.
- $<$ 5ppm for Resistance Weld.
- $<$ 10ppm for Solder Seal.

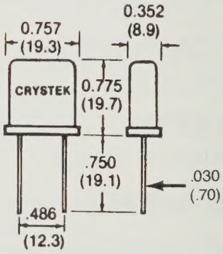
Standard types are solder sealed or resistance welded. Coldweld sealing is available at a slightly higher cost.

Crystal Holders:

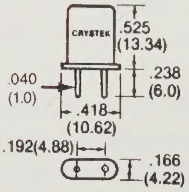
HC-6/U



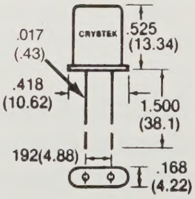
HC-33/U



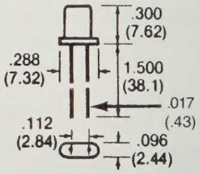
HC-25



HC-18



HC-44



NOTE: ALL DIMENSIONS IN INCHES AND MILLIMETERS

Standard "Custom Design" High Frequency

FREQUENCY RANGE 16 - 200 MHz,
[3rd, 5th, 7th, 9th mode of vibration]

Crystal Selection Guide

CRYSTEK P/N	FREQ. RANGE MHZ	MODE OF VIBRATION	R_s MAX	STANDARD TEMP. RANGE °C	FREQ. TOLERANCE OVER TEMP RANGE	HOLDER TYPE
HF-1	16-30	3	SEE FIG. 1	−30°C to +70°C	±.005% ±50ppm	HC-18/U HC-25/U
HF-2	31-60	3				
HF-3	61-70	3				
HF-4	60-100	5	SEE FIG. 2			
HF-5	101-125	5				
HF-6	125-150	7	120			
HF-7	151-175	7	140			
HF-8	176-200	9	200			
HF-9	40-59	3	SEE FIG. 1	−30°C to +70°C	±.005% ±50ppm	HC-44/U
HF-10	60-70	3				
HF-11	60-100	5	SEE FIG. 2			
HF-12	101-125	5				

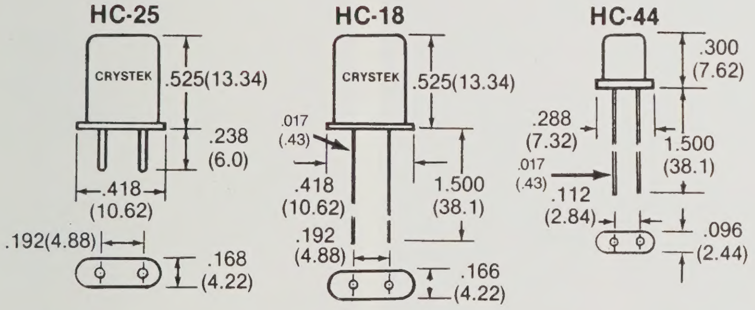
For closer freq. tolerances use the following code in addition to the **Crystek P/N.**

Code	Room Temp 25°C Tol. Setting	−30°C to +70°C
−1	±25ppm	±50ppm
−2	±10ppm	±50ppm
−3	±25ppm	±25ppm
−4	±10ppm	±25ppm

For **oven** type crystals use the following code.

Code	Reference Temp °C	Freq. Tol.
−5	+65, +70, +75, +80, +85	±20ppm
−6	Oven Stability ±1°C Max.	±10ppm

Crystal Holders:



NOTE: ALL DIMENSIONS IN INCHES AND MILLIMETERS

TYPICAL RESISTANCE
VS FREQUENCY
CHARACTERISTICS

FIGURE 1 — AT-CUT 3RD MODE TYPICAL R_s

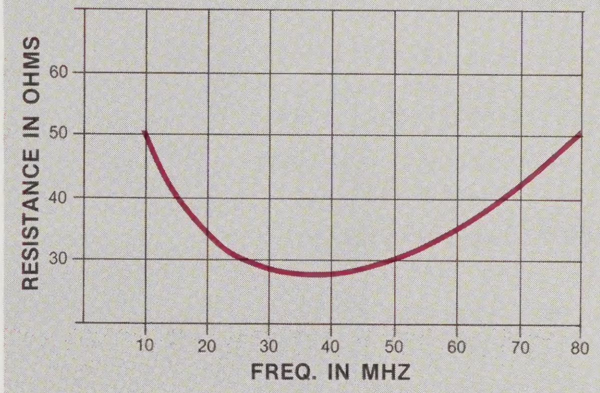
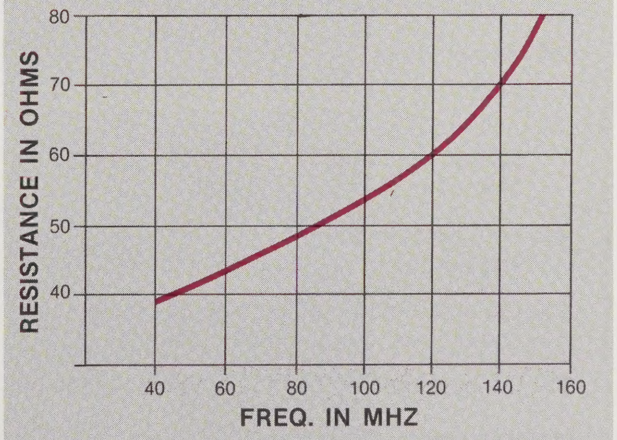


FIGURE 2 — AT-CUT 5TH MODE TYPICAL R_s



TO ORDER

- **Specify P/N (Code)**
- **Crystal Frequency**
- **Holder Type**
- **Load Capacitance or**
- **Series Resonance**

FACILITIES AND CAPABILITIES

Our in-house capability enables Crystek to manufacture crystal products from raw quartz to the finished product, using current state-of-the-art equipment available.

1/2. Fully automated sawing of wafers from the quartz stone. (±1 minute of arc tolerance.)

3. Multiblade quartz wafering saw.

4. Rounding of quartz blanks to specified diameters, centerless grinding machine. (±.001 inch tolerances.)

5/6. Planetary lapping of the rounded crystal blank to predetermined thickness and parallelism.

7. Polishing operation for optimum surface conditioning, (optical flatness controlled within ½ wavelength.)

8. X-ray measurement of angle of orientation double diffraction method. (±10 seconds of arc tolerance.)

9. Automated robotic blank sorting system.

10. Automated surface curve generator system. Contouring and bevelling of the blanks.

11. Ultrasonic cleaning and surface preparation.

12. Class 100 clean air working stations. Preparation of plating masks prior to base-coating (forming of electrodes).

13. Mounting of quartz blank in header (conductive cement application).

14/15. Base-coating operation. Cryo-pumped electron beam plating system.

16. Cryo-pumped automatic variable frequency platers.

17. Coldweld sealing process.

18. Resistance welding system.

19. Frequency marking of the crystal enclosure.

20. H-P 5061 atomic cesium-beam frequency standard. Accuracy ±1 part in 10^{11}.

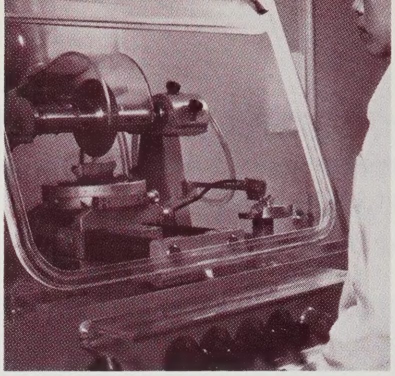
21. Zero-phase-vector voltmeter analyzer. ZVP-measurment of all crystal parameters.

22. Automated measurements of the crystal temperature coefficient. Z.P.V. measurement from −55° to +105° C.

23. H-P Spectrum analyzer. Detection of unwanted spurious modes.

24. Computerized aided design for all quartz crystal types.

25. General overview of part of the assembly line.



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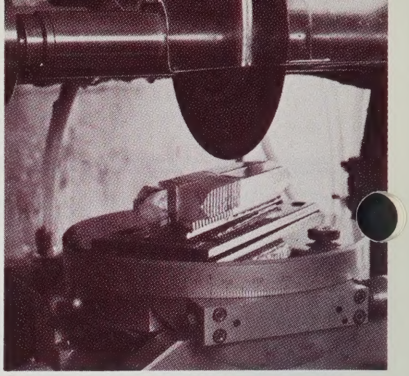

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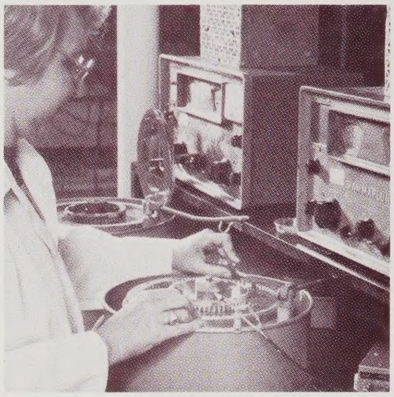

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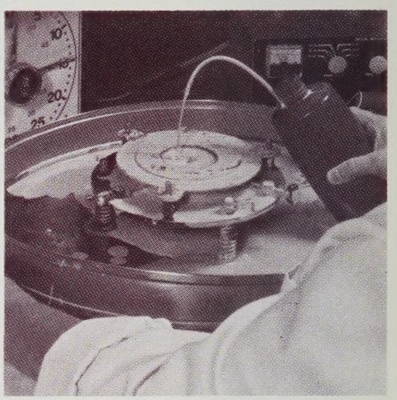

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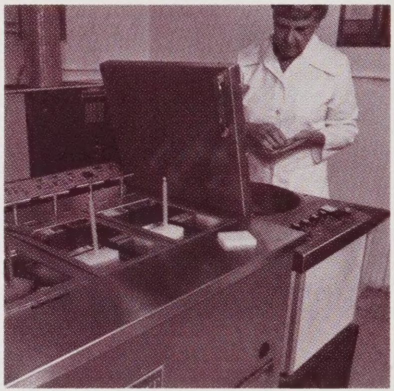

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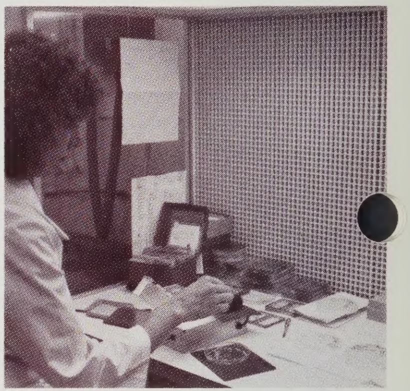

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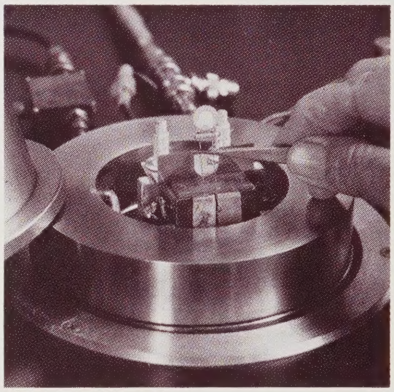

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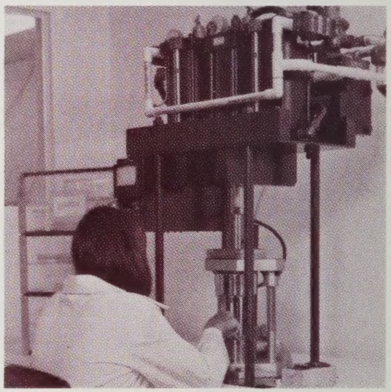

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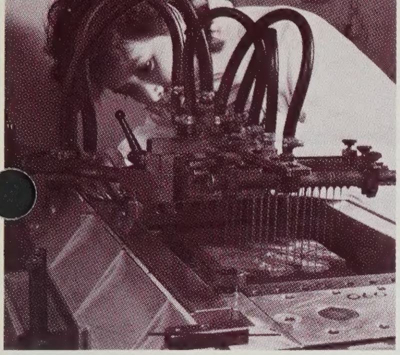
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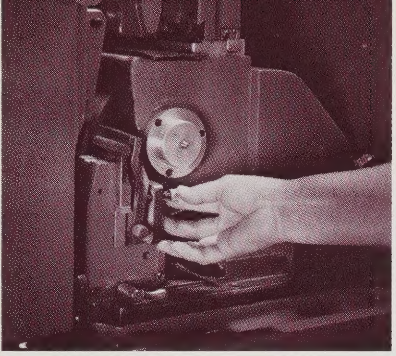
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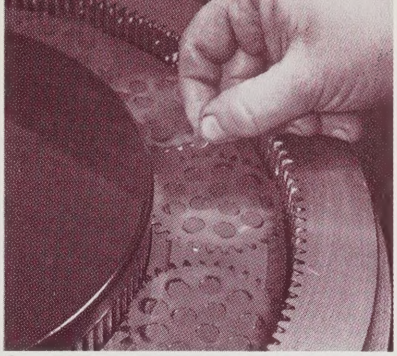
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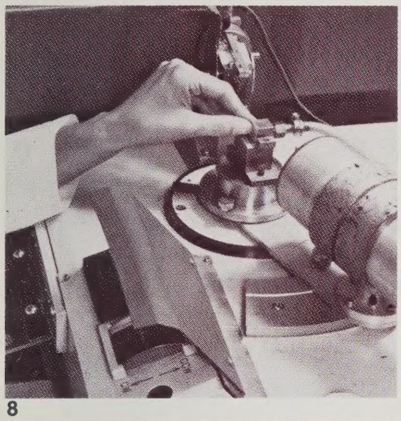
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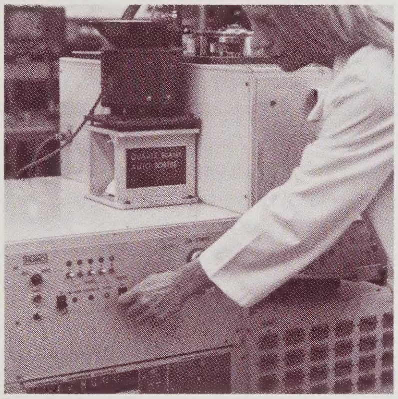
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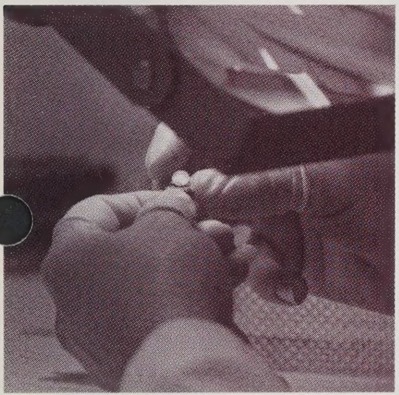
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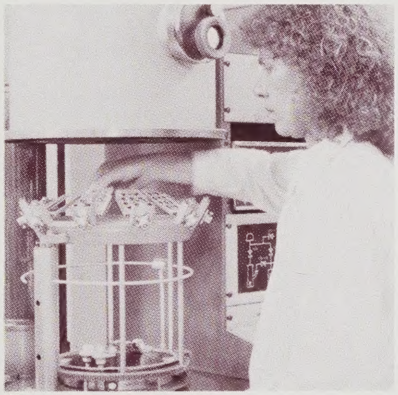
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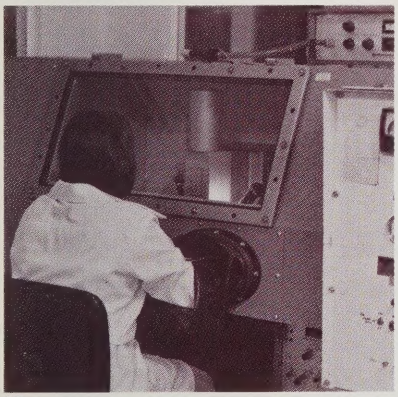
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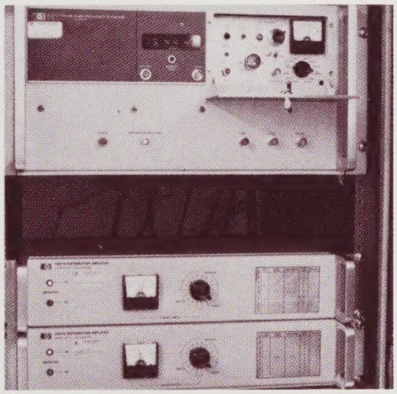
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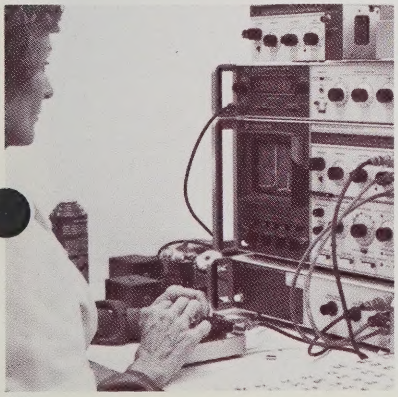
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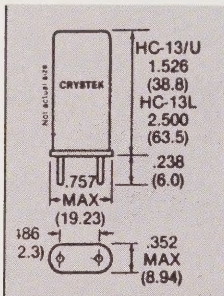
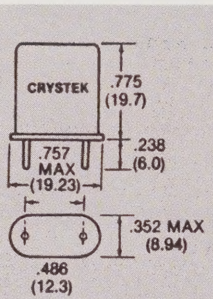
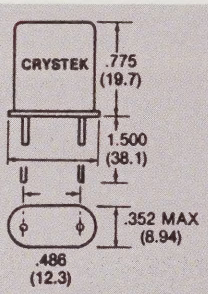
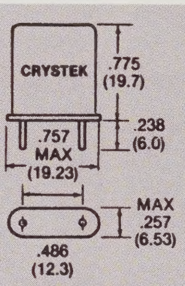
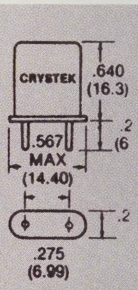
Crystal Holders

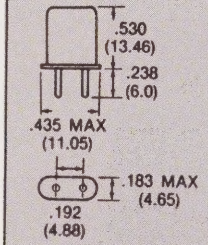
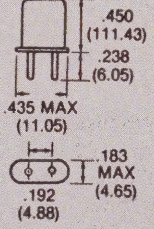
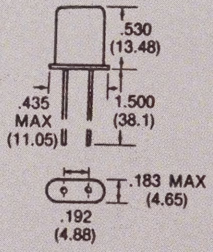
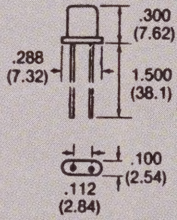
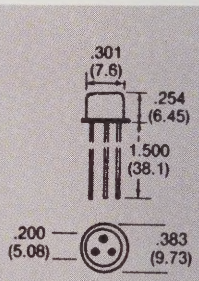
Hermetically sealed metal enclosures are utilized to contain the quartz crystal element in a contaminant free environment. **Crystek** offers 3 distinct methods of sealing:

Solder Seal: This method is cost effective and accepted for military and commercial applications. (Mil-C-3098) Nickel-silver cans and bases are soldered together with a tin-lead alloy.

Resistance Weld: Resistance welded enclosures are sealed together by melting the metal for a very short time with a large predetermined electrical pulse, thus welding the crystal cover to the base. No Fluxes are used in this process. The resistance-weld method has the advantages of approcaching the long term stability that of the coldweld method.

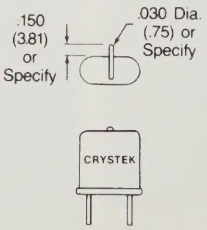
Coldweld: In the coldweld method a nickel plated copper can and base is sealed together under a concentrated high pressured bonding technique. The enclosure is evacuated using a cryogenic vacuum and backfilled with a mixture of helium and nitrogen. The coldweld method is exclusively used when long term stability is required (low aging characteristics).

	 Not actual size CRYSTEK HC-13/U 1.526 (38.8) HC-13L 2.500 (63.5) .238 (6.0) .757 MAX (19.23) 86 2.3) .352 MAX (8.94)	 CRYSTEK .775 (19.7) .238 (6.0) .757 MAX (19.23) .352 MAX (8.94) .486 (12.3)	 CRYSTEK .775 (19.7) 1.500 (38.1) .352 MAX (8.94) .486 (12.3) Wire Lead Type	 CRYSTEK .775 (19.7) .238 (6.0) .757 MAX (19.23) MAX .257 (6.53) .486 (12.3) Slim Line	 CRYSTEK .640 (16.3) .2 (6 .567 MAX (14.40) .2 .275 (6.99)
SOLDER SEAL	HC-13/U, HC-13L	HC-6/U	HC-33/U	HC-65	HC—32
RESISTANCE WELD	N/A	HC-48/U	HC-51/U	N/A	N/A
COLD WELD	N/A	HC-36/U	HC-47/U	N/A	N/A
WIRE/PIN DIAMETER	.050(1.3)	.050(1.3)	.030(.76)	.050(1.3)	.040(1.0)

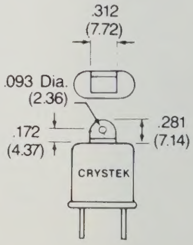
	 .530 (13.46) .238 (6.0) .435 MAX (11.05) .183 MAX (4.65) .192 (4.88)	 .450 (111.43) .238 (6.05) .435 MAX (11.05) .183 MAX (4.65) .192 (4.88)	 .530 (13.48) .435 MAX (11.05) 1.500 (38.1) .183 MAX (4.65) .192 (4.88)	 .300 (7.62) .288 (7.32) 1.500 (38.1) .100 (2.54) .112 (2.84)	 .301 (7.6) .254 (6.45) 1.500 (38.1) .200 (5.08) .383 (9.73)
SOLDER SEAL	HC-25/U	HC-25SHORT	HC-18/U	HC-44	N/A
RESISTANCE WELD	HC-50	N/A	HC-49/U	HC-44/45	N/A
COLD WELD	HC-42/U	N/A	HC-43/U	HC-45	HC-35 (TO -5)
WIRE/PIN DIAMETER	.040(1.0)	.040(1.0)	.017(.43)	.018(9.5)	.017(.43)

SPECIAL MOUNTING CONFIGURATIONS

Center Pin/Wire



Tab, End



1. HC-17/U = HC-6/U with .093″ diameter pins.
2. HC-33/U = HC-6/U with .030″ diameter wire leads.

Microprocessor Crystals

GENERAL SPECIFICATIONS

Frequencies available from **1** to **50** MHz.

Freq. Tolerance	:±.005% or 50ppm
Freq. Stability	:±.01% or 100ppm
Temp. Range	: −20℃ to +70℃
Shunt Capacitance	: < 7.0 pF
Aging Rate	: < 5 ppm/Year
Sealing Method	: Solder Seal or Resistance Weld.

Resistance weld/solder seal—supplier's option.

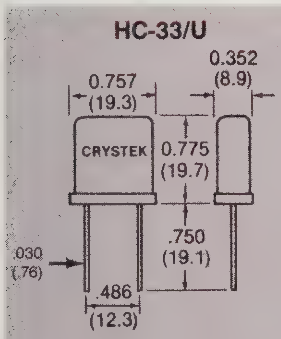
MOST FREQUENCIES AVAILABLE FOR IMMEDIATE DELIVERY FROM STOCK.

The list of Frequencies published on this page is only in a short form. A large number of Standard Frequencies is available on request as well as non-standard units.

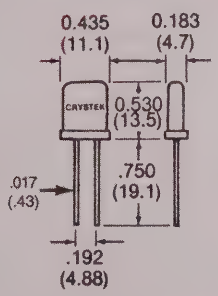
Cross-over information with other suppliers is available.

M-P Crystal Holders

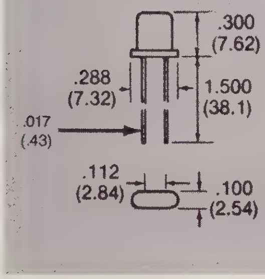
HC-33/U



HC-18/U



HC-44/U



HOLD DOWN WIRE ON REQUEST.

Crystek Part #	Frequency (MHZ)	Holder	Mode	Load Cap.	Max. ESR OHMS
CY1A	1.000	HC33	FUND	SERIES	800
CD1A	1.8432	HC33	FUND	13PF	550
CD1AM	1.8432	HC18	FUND	13PF	550
CY2A	2.000	HC33	FUND	SERIES	500
CY2AM	2.000	HC18	FUND	SERIES	500
CY2B	2.4576	HC33	FUND	32PF	320
CY2BM	2.4576	HC18	FUND	32PF	320
CY3G	3.000	HC33	FUND	SERIES	175
CY3GM	3.000	HC18	FUND	SERIES	175
CY3B	3.2768	HC33	FUND	18PF	175
CY3BM	2.2768	HC18	FUND	18PF	175
CY3C	3.330	HC33	FUND	SERIES	175
CY3CM	3.330	HC18	FUND	SERIES	175
CY3D	3.579545	HC33	FUND	18PF	175
CY3DM	3.579545	HC18	FUND	18PF	175
CY3JM	3.6864	HC18	FUND	18PF	175
CY3A	4.0000	HC18	FUND	SERIEs	100
CY4F	4.096	HC18	FUND	20PF	100
CY4E	4.194304	HC18	FUND	12PF	75
CY4D	4.9152	HC18	FUND	SERIES	75
CY7A	5.000	HC18	FUND	SERIES	50
CY5B	5.0688	HC18	FUND	SERIES	50
CY8A	5.185	HC18	FUND	SERIES	50
CB5C	5.7143	HC18	FUND	SERIES	50
CY5E	5.760	HC18	FUND	32PF	50
CY6B	6.000	HC18	FUND	SERIES	40
CY6C	6.144	HC18	FUND	30PF	40
CY6D	6.5536	HC18	FUND	22PF	40
CY6E	6.666	HC18	FUND	SERIES	40
CY7C	7.15909	HC18	FUND	20PF	30
CY7B	7.3728	HC18	FUND	SERIES	30
CY8G	8.000	HC18	FUND	SERIES	30
CY8D	8.000	HC18	FUND	SERIES	30
CY9B	9.8304	HC18	FUND	SERIES	30
CY12A	10.000	HC18	FUND	SERIES	30
CY11B	11.0592	HC18	FUND	SERIES	30
CY12B	12.000	HC18	FUND	SERIES	30
CY13A	13.5168	HC18	FUND	SERIES	30
CY14A	14.31818	HC18	FUND	SERIES	30
CY14B	14.7456	HC18	FUND	SERIES	30
CY15A	15.000	HC18	FUND	SERIES	30
CY16B	16.000	HC18	FUND	SERIES	30
CY16A	16.58880	HC18	FUND	SERIES	30
CY19A	18.000	HC18	FUND	SERIES	30
CY19B	18.432	HC18	FUND	SERIES	30
CY20A	19.6608	HC18	FUND	SERIES	30
CY22A	20.000	HC18	FUND	SERIES	30
CY22B	22.1184	HC18	FUND	SERIES	30
M8A	8.000	HC44	FUND	SERIES	80
M10A	10.000	HC44	FUND	SERIES	60
M12A	12.000	HC44	FUND	SERIES	60
M15A	15.000	HC44	FUND	SERIES	55
M18E	18.4320	HC44	FUND	SERIES	40
M19D	19.3540	HC44	FUND	SERIES	40
M19G	19.6608	HC44	FUND	SERIES	40
M22B	22.1184	HC44	FUND	SERIES	40
M24A	24.000	HC44	FUND	SERIES	40
M25A	25.000	HC44	FUND	SERIES	40

Crystal Clock Oscillators

LOW COST HYBRID DIP CLOCK OSCILLATORS

Frequency Stability: ±0.0025% to ±1.0%

Operating Temperature: 0°~70℃

Storage Temperature: −55°~+125℃

Crystek Crystal clock oscillators combine the latest technological advances and automated production techniques.

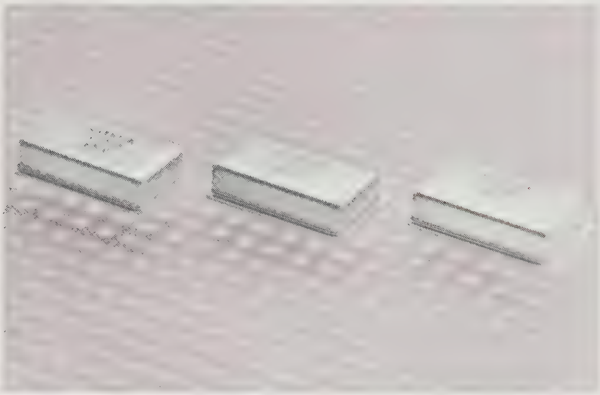
Some Important Features:

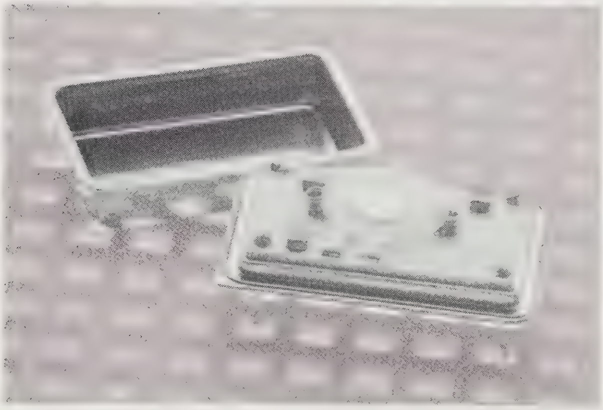
Low Power Consumption
Hermetically "resistance weld" sealed
Reliable, durable, economical

Crystek's experience and expertise in crystals and crystal oscillators assures our customers of dependable quality and state-of-the art designs.

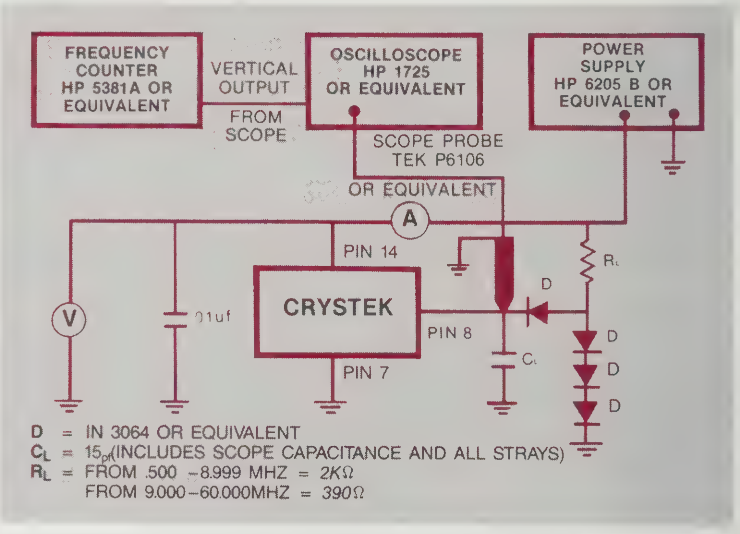
SPECIFICATIONS	TTL			CMOS	
MODEL	CCO-010			CCO-020	
FREQUENCY RANGE (MHz)	0.255—4	3.5—25	24—60	2—20	20—40
SYMMETRY @ 1.4V LEVEL	50/50±5%	50/50±10%	50/50±10%	@50% LEVEL 50/50±10%	@50% LEVEL 50/50±10%
Tr and Tf (ns) (Max)	15	10	7	25	20
VoH (Logic "1") (Min)	+2.4	+2.4	+2.4	VDD-0.2(V)	VDD-0.2(V)
VoL (Logic "O") (Max)	+0.4	+0.4	+0.5	0.2V	0.2V
SUPPLY VOLTAGE (V)	5+5%	5±5%	5±5%	5±10%	5±10%
SUPPLY CURRENT (mA) (Max)	90	30	70	8	30
OUTPUT LOAD	TTL Compatible 1=10 TTL Loads			CMOS Compatible	

TYPICAL TESTING METHOD OF CLOCK OSCILLATORS



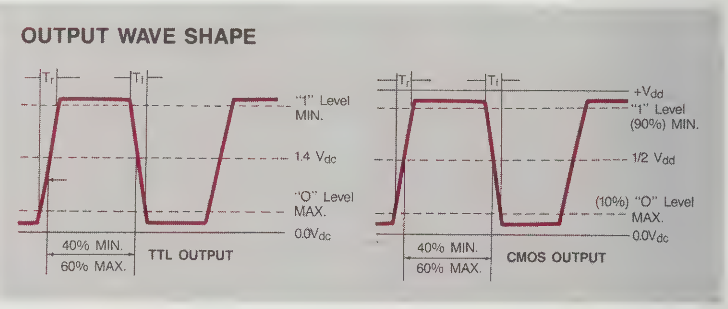


FOR PRICING AND METHOD OF ORDERING SEE PRICE SHEET

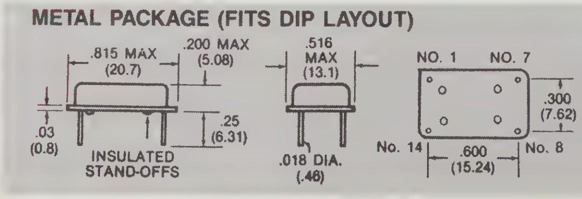

FREQUENCY COUNTER HP 5381A OR EQUIVALENT
VERTICAL OUTPUT FROM SCOPE
OSCILLOSCOPE HP 1725 OR EQUIVALENT
POWER SUPPLY HP 6205 B OR EQUIVALENT
SCOPE PROBE TEK P6106 OR EQUIVALENT
A
PIN 14
V
.01uf
CRYSTEK
PIN 8
PIN 7
D
R_L
C_L
D
D
D

D = IN 3064 OR EQUIVALENT
C_L = 15_{pf}(INCLUDES SCOPE CAPACITANCE AND ALL STRAYS)
R_L = FROM .500 –8.999 MHZ = 2KΩ
FROM 9.000–60.000MHZ = 390Ω

OUTPUT WAVE SHAPE



METAL PACKAGE (FITS DIP LAYOUT)



CONNECTION
PIN 1—N/C
PIN 7—GND
PIN 8—OUTPUT
PIN 14— + V_{cc}

Temperature Compensated Crystal Oscillators

SURFACE MOUNTED (TCXO)

The avant-garde technology at Crystek of the thick film and surface mount methods together with the development of a precise technique of crystal coefficient curve fitting allows a superior coordination of computerized temperature compensating networks which are required for close tolerance crystal oscillators.

The frequency versus temperature curve of an "AT-cut" quartz is compensated by means of a varicap diode biased from a thermistor/resistor network which flattens the normal s-shaped curve.

Some typical TCXO stablities over a temperature range are shown

FREQUENCY TOLERANCE	AMBIENT TEMPERATURE ° C
±1 PPM	−40° TO + 70°
±2 PPM	−40° TO + 85°
±5 PPM	−40° TO + 85°

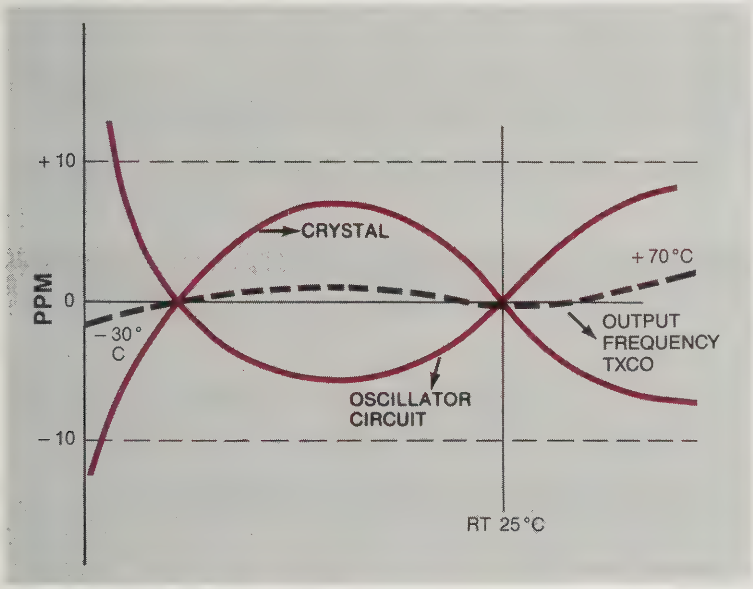
The basic oscillator deisngs are developed by using C.A.D./C.A.M. methods.

Our engineering professionals promptly will respond to any of your oscillator requirements and special specifications.

TCXO PRINCIPAL

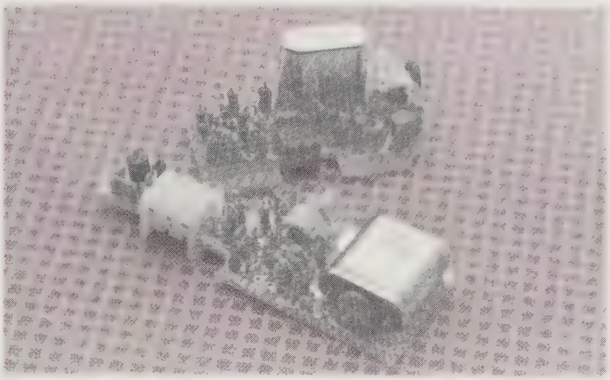
A thermistor/resistor network creates a voltage variation versus temperature change, this voltage is applied to a varactor across the crystal.

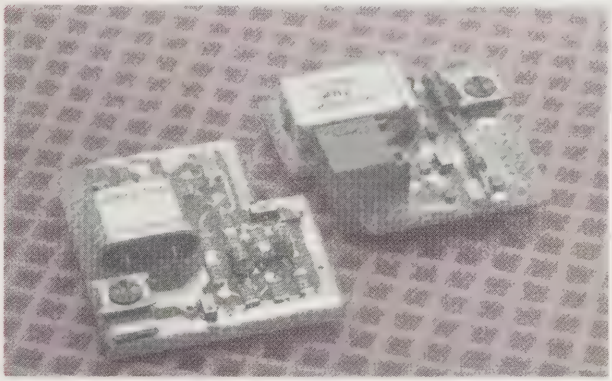
Precisely computerized analysis will design a frequency shift caused by the varicap variation canceling the crystal's frequency/temperature characteristic, which results in a reduced frequency deviation at the output of the oscillator over the temperature range.

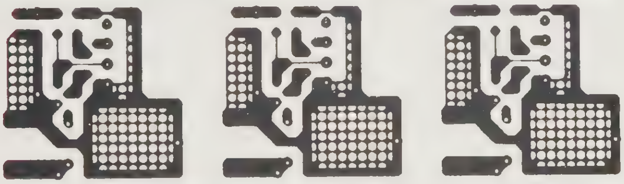


EXAMPLE OF TXCO COMPENSATION

FREQUENCY RANGE 3 - 200 MHz







Land and Mobile Pager Crystals

COMMERCIAL TWO-WAY COMMUNICATION REPLACEMENT CRYSTALS AND CHANNEL-ELEMENTS

The Frequency Management Department at **Crystek** maintains a Computer data base listing of most all technical information on today's LAND-MOBILE RADIO COMMUNICATION Equipment including Data required to precisely manufacture the Crystals and Channel-Elements.

CRYSTEK manufactures and installs crystals in Channel Elements when the module is supplied by the customer.

This service of installing consists of the following:

- The module will be 100% tested for proper operation upon receipt.
- Remove old and install new crystal.
- If module is a TCXO the applicable compensation network will be changed.
- Set module on center frequency.
- Measure R F output signal and trimmability of the module.
- Measure overall frequency deviation versus temperature change according to specifications.
- If the module received is defective a test report will be sent to the customer.

Replacement Crystals are available in the following Frequency Range:

VHF	Low-Band	25-54 Mhz
VHF	High-Band	144-174 Mhz
UHF	Band	440-512 Mhz
UHF	Band	800-950 Mhz

CRYSTALS/CHANNEL-ELEMENTS for:

• AEROTRON • HARRIS • MOTOROLA • WILSON •GENERAL ELECTRIC•E.F. JOHNSON•REPCO•RCA

FURTHER INFORMATION ON PRICING AND SERVICE ON THE ABOVE MENTIONED CRYSTALS AND CHANNEL-ELEMENTS AVAILABLE ON REQUEST. PLEASE USE OUR TOLL FREE TELEPHONE NUMBER

1-800-237-3061

8:00 a.m. to 5:00 p.m. (Monday-Friday)

TOLL FREE IN THE USA EXCEPT FLORIDA, ALASKA, HAWAII

High Quality Custom Made Crystals for

MARINE VHF TRANSCEIVERS

	Transmit	Receive
Channel Frequency	156.275 to 157.425 MHz	156.275 to 162.550 MHz
Holder	HC25	HC25
Operating Temperature Range	−30 to +60°C	−30 to +60°C
Frequency Tolerance at 25°C	±.001% to ±.002%	±.001% to ±.002%

AIRCRAFT TRANSCEIVERS

	Transmit	Receive
Operating Frequency Range	118 to 138 MHz	118 to 138 MHz
Holder	HC18, HC25 or Specials	HC18, HC25 or Specials
Operating Temperature Range	−10 to +60°C	−10 to +60°C
Frequency Tolerance at 25°C	±.002%	±.002%

MONITOR RADIO (SCANNER)

	Low V.H.F.	High V.H.F.	U.H.F.
Operating Frequency Range	30 to 50 MHz	150 to 170 MHz	450 to 470 MHz
Holder	HC25	HC25	HC25
Frequency Tolerance at 25°C	±.001% to ±.002%	±.001% to ±.002%	±.001% to ±.002%

AMATEUR TWO-METER TRANSCEIVERS

	Transmit	Receive
Operating Frequency	144 to 148	144 to 148
Holder	HC25	HC25
Operating Frequency Range	−10 to +60°C	−10 to +60°C
Frequency Tolerance at 25°C	±.002%	±.002%

CB TRANSCEIVERS

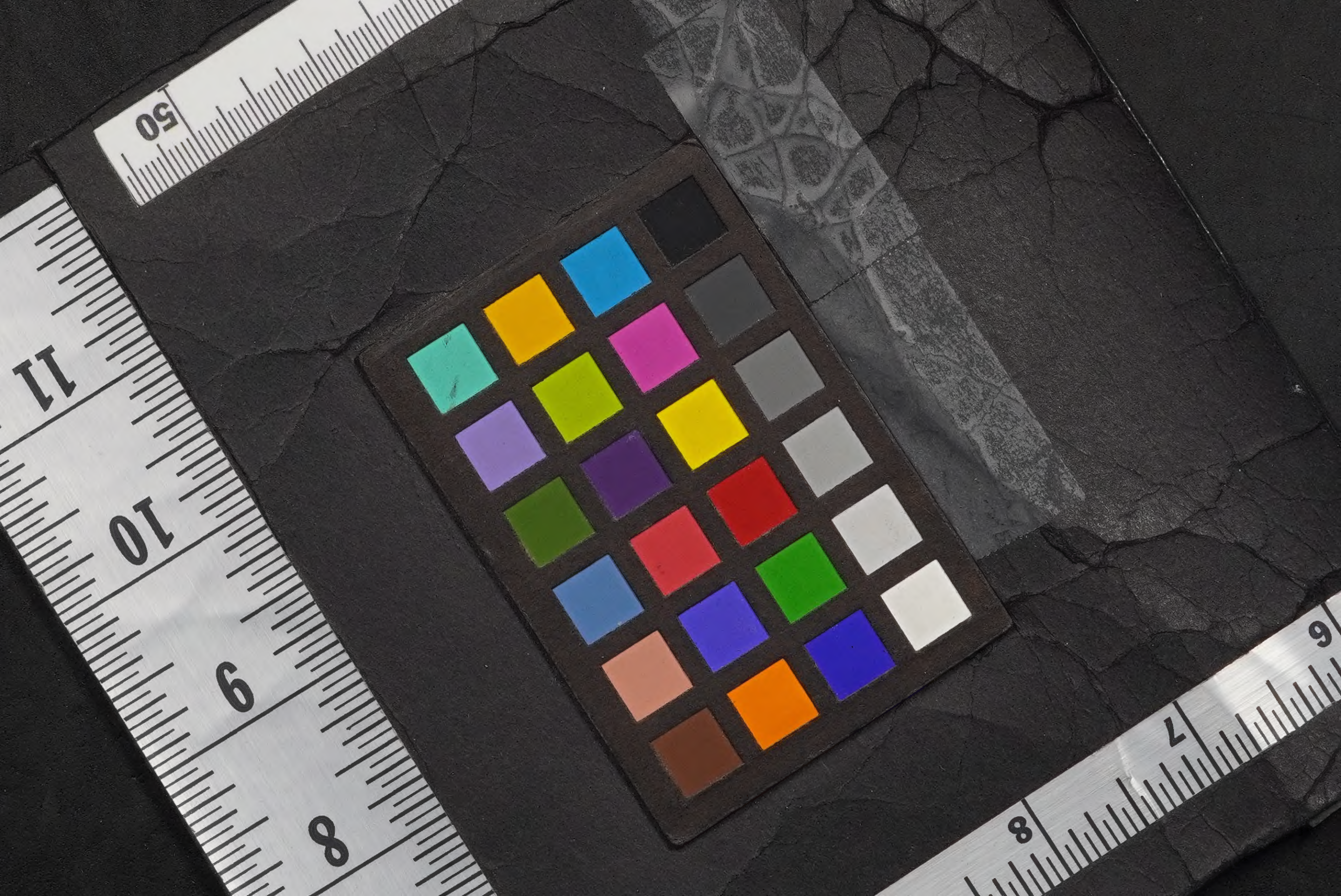
CB CRYSTALS FOR SYNTHESIZED / NON SYNTHESIZED SETS CH 1-40
CB CRYSTALS FOR PHASE LOCK LOOP TRANSCEIVERS

	Non Synthesized Sets	Synthesized Sets
Frequency Range/Channel	26.965 to 27.405 MHz	From 7 MHz to 38 Mhz
Holder	HC18, HC25 or HC6	HC18 or HC25
Frequency Tolerance at 25°C	±.002% to ±.005%	±.001% to ±.005%

***Crystek** maintains a computer database on most all technical information, specifications and crystal data for the above listed communication devices.*

*The database is constantly updated and allows **Crystek** to manufacture a direct replacement crystal according to the original equipment manufacturer specifications.*

For pricing and ordering method check-off the ordering form enclosed.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